

COPPER DEFICIENCY OF PLANTS

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Plants require about 21 elements in order to grow and reproduce normally. Besides carbon, which is absorbed as CO<sub>2</sub> from the atmosphere, and hydrogen and oxygen, which are absorbed as water, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) are required in relatively large amounts and are called macronutrients. The term micronutrient is used by plant nutritionists to describe those elements that are required in minute amounts. The generally recognized micronutrients are: iron (Fe), copper (Cu), manganese (Mn), zinc (Zn), molybdenum (Mo), cobalt (Co), boron (B), chlorine (Cl), sodium (Na), vanadium (V), and silicon (Si). Not all of these elements are required by all plants, but all have been proved essential for some plants. Besides the 21 elements listed above, aluminum (Al), strontium (Sr), rubidium (Rb), and selenium (Se) have been shown beneficial, but not essential, to some plants at least under certain environmental conditions (7). Plants normally absorb these essential and beneficial elements through their roots, although some foliar absorption is possible if the element is applied in water-soluble form.

When a plant lacks one of its essential nutrients, it will present an array of symptoms, subtle or obvious, depending upon the nutrient which is deficient and the degree of the deficiency. Deficient plants not only develop abnormally, but they can also cause nutrient deficiencies in animals which consume them. With some training and practice, one can recognize with a certain degree of reliability the deficiency symptoms of a particular nutrient on a specific plant under ideal conditions. However, many situations are such that not one but two or more nutrients are deficient at the same time, and symptoms of several deficiencies are expressed simultaneously. Combine this multiple deficiency syndrome with other environmental factors which also affect the appearance of a plant, and one has a situation in which only soil testing and/or foliar analysis with comparison to experimentally obtained acceptable nutrient levels for a particular plant can be used to diagnose the deficiency. Without access to sophisticated soil testing and foliage analysis facilities, the diagnosis of nutrient deficiency is often a matter of eliminating all other possible causal agents which could produce similar symptoms.

The types of agriculture practiced in Florida and the nature of Florida soils make plants grown here especially prone to nutrient deficiency diseases. Container-grown plants are raised almost exclusively in soilless mixes to which most nutrients must be added. The acid, sandy soils of North Florida are easily leached by abundant rainfall. The alkaline, marl soils of South Florida have problems with nutrients being tied up or "fixed" in insoluble forms, thus unavailable for plant absorption. The peat and muck soils scattered throughout the state are also known to lack certain micronutrients and some have a tendency to hold added nutrients so tightly in organic complexes that plants may have trouble retrieving them.

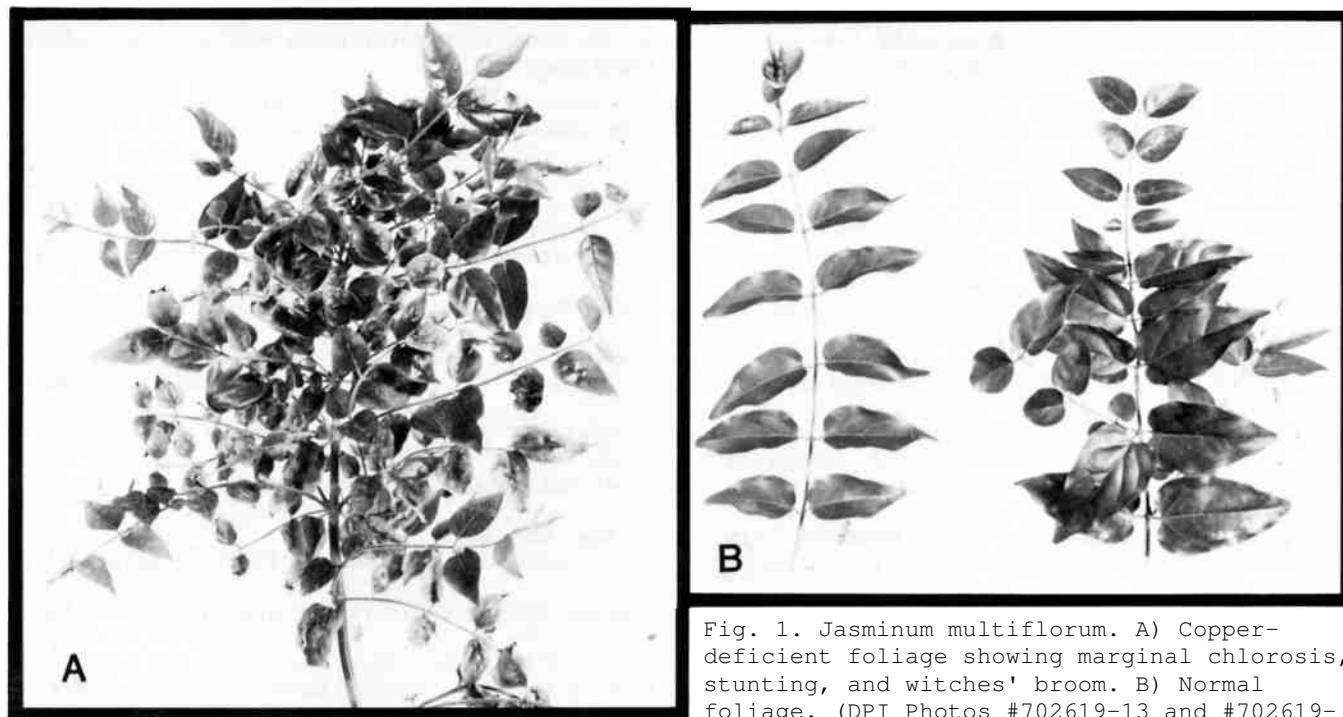


Fig. 1. *Jasminum multiflorum*. A) Copper-deficient foliage showing marginal chlorosis, stunting, and witches' broom. B) Normal foliage. (DPI Photos #702619-13 and #702619-19)

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One of the most common micronutrient deficiencies observed in Florida is that of copper. Exanthema in citrus has been a problem since about 1875 (4,5,8), but copper deficiency was not positively recognized as its cause until 1935 (6). Longstanding problems with copper deficiency have been reported in vegetables grown on sawgrass peat in the Everglades. Tung trees raised in North Central Florida frequently suffered from copper deficiency during the 1940s when their culture was popular (3).

Copper in soils becomes most available at pH 6 or lower, though usually adequate amounts are soluble at pH 7 or less. Iron, manganese, zinc, and cobalt also behave similarly in soils (1). In Florida's acid, sandy soils, it is likely that all would be easily leached from the root zone. Native sandy soils testing 50 lbs total copper/A 6" are considered adequate for plant nutrition (9).

Copper is absorbed by plants as the cupric ion ( $\text{Cu}^{2+}$ ) (12). Copper content of plant foliage is generally considered deficient if at 4 ppm or less. Acceptable levels range from 5-20 ppm copper (10), though copper is at toxic levels for some plants near the top of this range. Copper serves as an activator for several oxidizing enzymes in plant metabolism and is a constituent of an enzyme important in the utilization of protein and chlorophyll formation (11). The element is not mobile in plant tissues; thus young tissues will show deficiency symptoms first.

**SYMPTOMS.** Symptoms of copper deficiency can be quite dramatic, especially when the deficiency is severe. Chlorosis is generally an early symptom, though exanthema in citrus lacks this symptom at least in early stages. In most plants, young foliage is severely stunted as well as chlorotic. Deficient foliage can be cupped and deformed (tung), bleached (lettuce), flaccid and blue green with chlorotic margins (tomato), abscise early (walnut), and eventually become necrotic in the interveinal areas (tung). In citrus, first symptoms are a few long vigorous shoots with dark green, large leaves, with yellow blotches on the stem beside or below the leaf scar. These yellow blotches swell, fill with gum, become necrotic, and can girdle the branch (9). On many plants, a chronic deficiency results in twig death, followed by stimulation of many lateral buds below the dieback which in turn also die (Fig. 1). The resulting proliferation and witches' broom are common symptoms of copper deficiency in woody plants.

**TREATMENT/CONTROL.** Before corrective measures for copper deficiency are undertaken, a reasonably certain diagnosis of copper deficiency should be made. Copper and certain other micronutrients can quickly reach toxic levels if applied when adequate supplies already exist. Repeated use of copper containing fungicides in citrus has made copper toxicity more common than copper deficiency in this industry (9). Often it is best to test the effects of added micronutrients on a small scale to determine if results will be desirable.

Soil application of copper sulfate is the most common method to correct a deficiency of copper in soils such as acidic sands or muck/peat soils. Soils testing 2-100 ppm Cu should be able to adequately supply plant needs (12). Copper deficiency due to high soil pH should be treated by lowering soil pH with acidifiers such as sulfur or ammonium sulfate. For immediate therapy, foliar application of copper sulfate at 3 oz/2 gal water with 1/3 oz of hydrated lime (2), copper containing fungicides, or copper chelates can provide rapid, though perhaps transient, relief. Many complete fertilizers are available which contain both macro- and micronutrients in proper proportions. If copper and/or other micronutrients are already at threshold deficiency levels, the use of macronutrient fertilizers without added micronutrients can bring on deficiency symptoms where none existed previously.

**SURVEY AND DETECTION.** Look for stunted, chlorotic young growth on woody and herbaceous plants. Chronic copper deficiency symptoms often display bud proliferation and witches' brooms.

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